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U1S S1063

(56) Documents cited
GB 2049539 A GB 0636283 A EP 0226123 A2
EP 0035310 A1 US 3240854 A

(58) Field of search
UK CL (Edition J) B5A AD23
INT CL^{4} B29C

(54) Casting lenses in plastic: curing by radiation

(57) A method of casting plastic lenses from a radiation curable plastic material comprising the steps of separately holding first and second moulds 1, 2, at least one of which is transparent to the curing radiation, positioning them relative to one another so as to define the front and back surfaces of a lens to be cast, clamping the moulds in position, applying a sleeve 26 to form a closed cavity between the moulds, filling the cavity with the radiation curable plastic material 31 and curing the material by exposure to radiation until the plastic material is capable of keeping the first and second moulds in the desired spaced apart relationship when the mould clamps 27-30 are removed before final curing.

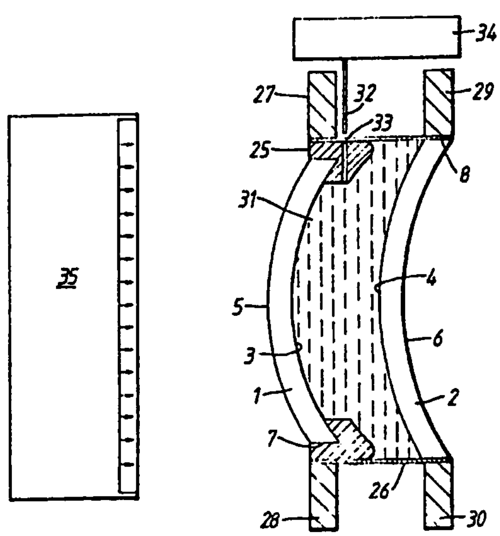

Fig.5.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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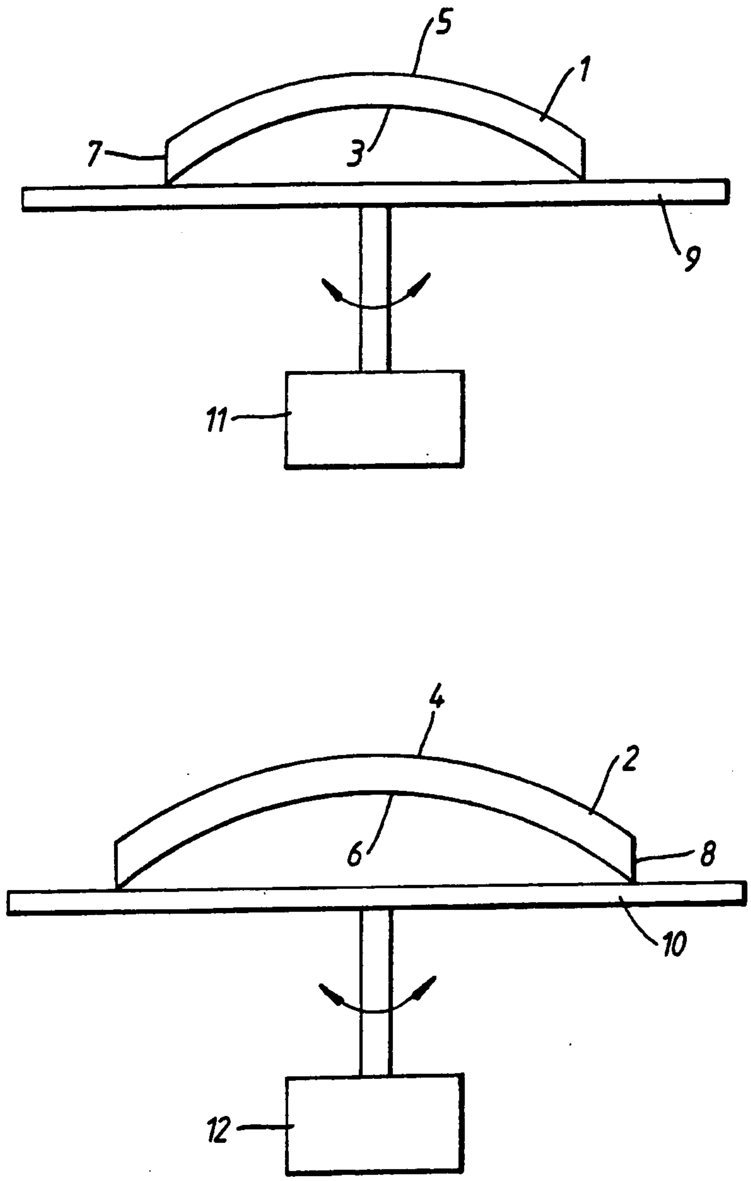

Fig.1.

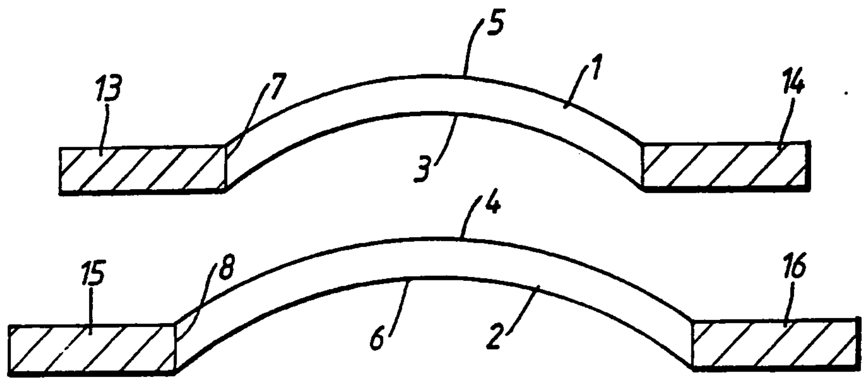

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Fig. 2.

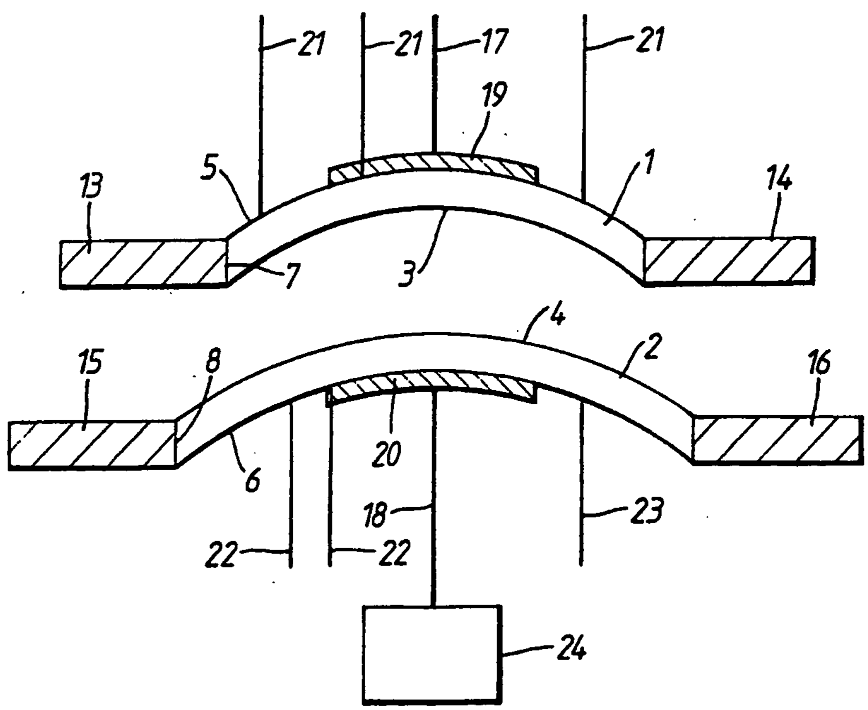

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Fig. 3.

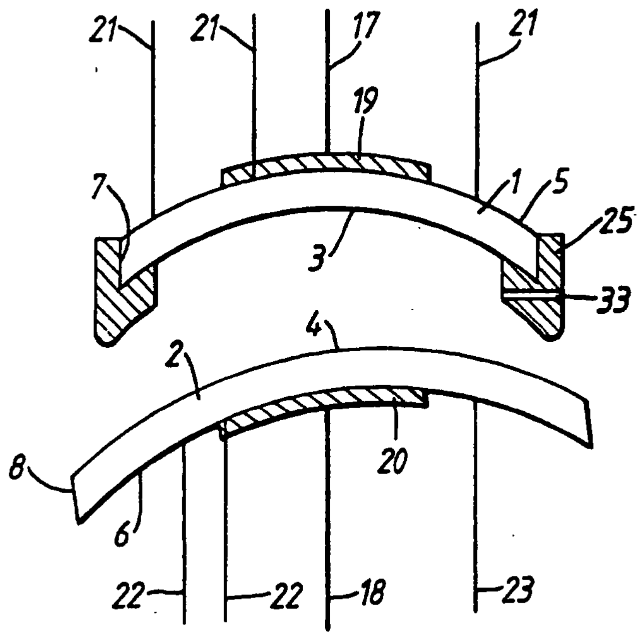
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Fig.4.

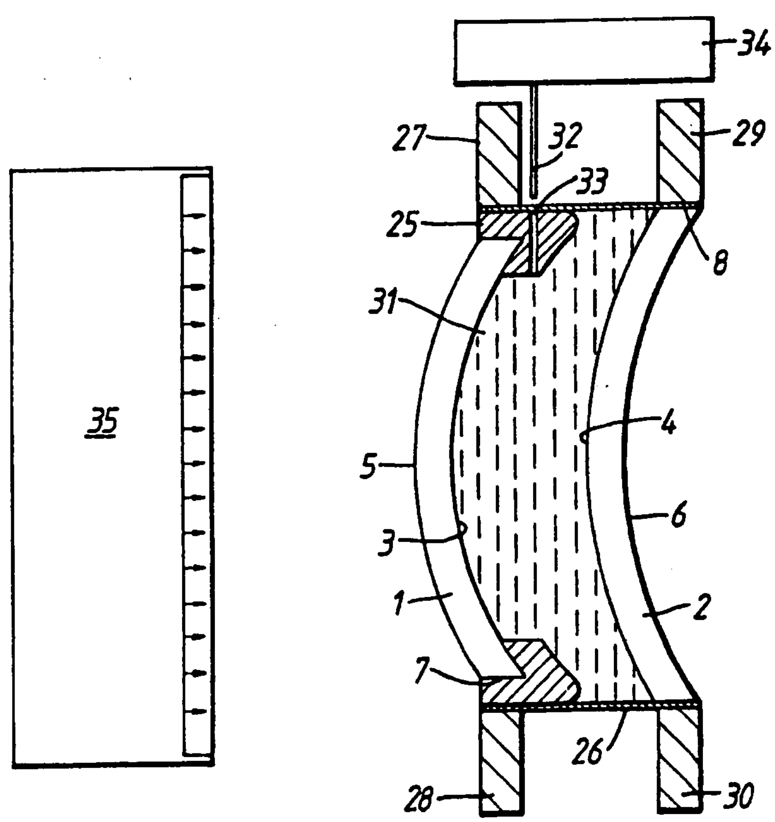
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Fig.5.

A method of casting plastic lenses

The present invention relates to a method of casting plastic lenses by casting a material in a pair of moulds shaped to the desired finished surface of the lens. This includes the casting of lenses to a final prescription form.

The automation of casting lines and the reduction of the need for the casting and ancillary operations to involve manual operations is the present goal of plastic lens manufacturers. One problem in attaining this goal is the relative complexity of the operations involved in assembling the moulds into a form for filling with the raw material from which the lens is formed. This involves not only feeding the right moulds to an assembly station but also the correct gasket for the particular type of lens being made. The T shaped gasket made of a plastic material acts as a separator and seal between the two moulds. One way of avoiding the need for many types of gasket which has been described in US 3240854 is a tube gasket system in which the moulds are placed within the tube gasket and then adjusted in position relative to one another by being forced against pre-set bull-nosed pins by compressed air which is injected between the two moulds to form a cavity between them which will provide the desired lens shape. The cavity is then filled and the material cured. However it is difficult to maintain the correct relative position of the

moulds, particularly where there is any sort of fine positioning such as to introduce prism into the finished lens, or during the normal filling operation. As the filled mould assembly is moved to its heat curing position, the handling can disturb the moulds from their predetermined position relative to one another. It is desirable to be able to cast lenses to their final prescription shape and in our published application GB 2049539A we have described a system of doing so in which the positioning of the moulds relative to one another is achieved by the interaction of two gaskets. The present invention allows the production of lenses cast to prescription without using this arrangement of interacting gaskets.

According to the invention, therefore, there is provided a method of casting plastic lenses from a radiation curable plastic material comprising the steps of separately holding first and second moulds, at least one of which is transparent to the curing radiation, positioning them relative to one another so as to define the front and back surfaces of a lens to be cast, clamping the moulds in position, applying a sleeve to form a closed cavity between the moulds, filling the cavity with the radiation curable plastic material and curing the material by exposure to radiation until the plastic material is capable of keeping the first and second moulds in the desired spaced apart relationship when the mould clamps are removed before final curing.

The curing radiation is preferably ultra-violet radiation.

The sleeve may be applied after the moulds have been correctly

positioned.

The plastic material is preferably cured until it reaches the gelled state.

The radiation transparent mould preferably allows uniform transmission of the curing radiation through the mould. The radiation transparent mould is more preferably a glass mould.

The sleeve can be simply a thin flexible plastic sheet which is wrapped round the two moulds. It can be overlapped on itself and sealed with adhesive. Other materials which can be used include plastic material which when punctured with a needle is capable of re-sealing, adhesive tape and films of the type used for shrink wrapping. A conventional tube gasket provided with at least one filling aperture can also be used. Advantageously the sleeve is transparent to the curing radiation, however it need not be since the material within the casting cavity can be irradiated with the curing radiation through the glass mould.

Using such a material, the plastic monomer or monomer mixture can be simply injected through the sleeve wall using a syringe type needle with a sensor to cut off monomer flow when the cavity is full.

The moulds can be positioned relative to one another by any mechanical means which enables the adjustment of their positions to be made accurately. This positioning may include driving at least part of at least one mould towards the other mould.

A mixture of UV curable monomers which with an appropriate

initiator or inhibitor will gell in about one to about sixty seconds on exposure to the curing radiation. Such mixtures are described in our co-pending Australian application PH 9090.

The invention will now be described, by way of example only, and with reference to the accompanying drawings, of which:

Figure 1 is a schematic representation of the moulds centred on the alignment tables

Figure 2 is a schematic representation of the moulds held by "V" blocks

Figure 3 is a schematic representation of the moulds being held by both "V" blocks and holders

Figure 4 is a schematic representation of the moulds after the required prism has been achieved

Figure 5 is a schematic representation of the assembly when it is ready for curing.

Figure 1 shows glass moulds 1 and 2, front mould 1 having a concave precision optical surface 3 and back mould 2 having a convex precision optical surface 4. Each mould 1 and 2 having a back surface curve 5 and 6 respectively, and a circular periphery 7 and 8. Figure 1 also shows front mould 1 on alignment table 9 vertically spaced from back mould 2 on alignment table 10. Each alignment table 9 and 10 may be rotated by rotation means 11 and 12 respectively.

Figure 2 shows "V"-blocks 13 and 14 engaging periphery 7 of front mould 1 and "V"-blocks 15 and 16 engaging periphery 8 of back mould 2. Moulds 1 and 2 are held in position by "V"-blocks 13,14,15 and 16.

Figure 3 shows the moulds 1 and 2 held by "V"-blocks 13 and 14, 15 and 16 respectively. Also shown are holders 17 and 18 each having a central suction cap 19 and 20. Holders 17 and 18 may be driven towards or away from moulds 1 and 2 respectively by driving means (not shown). Holder 17 also having three pins 21 each equally spaced about suction cap 19 each of pins 21 being spring loaded and clampable. Holder 18 having two spring loaded clampable pins 22. Holder 18 also having a third pin 23 which may be driven towards or away from the back surface 6 of back mould 2 by driving means 24. The three pins 22 and 23 of holder 18 are equally spaced about suction cap 20.

Figure 4 shows moulds 1 and 2 being held by the holders 17 and 18 respectively. The front mould 1 having its periphery 7 surrounded by an annular ring insert 25. The insert 25 having an "L"-shaped cross-section extending it over a peripheral part of the concave precision optical surface 3 of front mould 1.

Figure 5 shows the glass moulds 1 and 2 rotated through 90° with an adhesive self sealing tape 26 wrapped around the moulds 1 and 2, front mould 1 being held in place by grippers 27 and 28, back mould 2 being held in place by grippers 29 and 30. The tape 26 and moulds 1 and 2 defining a volume 31. Also shown is injection means 32 aligned with hole 33 in insert 25. The

injection means 32 is coupled to an injection unit/sensing unit 34. Figure 5 also shows means 35 for irradiating the volume 31 with the curing radiation through the glass moulds 1 and 2. The curing radiation may be, for example, ultra-violet or visible light or an electron beam. Irradiation means 35 may also be a laser.

With reference to figure 1, the glass moulds 1 and 2 are placed centrally on alignment tables 9 and 10 respectively by grippers (not shown). At least one of the moulds 1 or 2 has a polished or frosted back surface curve, 5 and 6 respectively which allows the uniform transmission of curing radiation through the mould. The moulds 1 and 2 are then rotated axially into position offset from a reference angle corresponding to the desired axis of prism by separate rotation of the alignment tables 9 and 10. This position is such as to enable the desired prism to be introduced at a later stage without further axial alignment of moulds 1 and 2.

"V" blocks 13 and 14 then hold front mould 1 in place by contacting periphery 7, as shown in figure 2. "V" blocks 15 and 16 hold back mould 2 by contacting periphery 8.

The alignment tables 9 and 10 are lowered slightly to take them out of contact with the moulds and to allow the moulds to be translated in the "V" blocks 13 and 14 to the prism/setting position. At which position front mould 1 is directly above back mould 2, and the optical axis of front mould 1 is co-axial with the optical axis of back mould 2.

Whilst in this position holders 17 and 18 are both driven towards the back surface curve of moulds 1 and 2 respectively, see

figure 3. Sprung pins 21 of holder 17 first touch the back surface curve 5 of front mould 1. Pins 21 being pushed back against their springs (not shown) until suction cap 19 engages back surface curve 5. The pins 21 are then clamped in position.

The two sprung pins 22 of holder 18 touch the back surface curve 6 of back mould 2. Pins 22 are pushed back against their springs (not shown) until suction cap 20 engages back surface curve 6. The pins 22 are then clamped in position. Pin 23 is then driven by driver means 24 towards the back surface curve 6 of back mould 2. On contacting back surface curve 6, driving means 24 halts pin 23 and this position is established as a datum for the later application of the required prism. "V"-blocks 13, 14, 15 and 16 are then retracted from peripheries 7 and 8. Moulds 1 and 2 are now held in position by holders 17 and 18.

As shown in figure 4, pin 23 is then further driven towards front mould 1 by driving means 24 to obtain the required amount of prism between the two moulds. The earlier alignment of the moulds 1 and 2 on alignment tables 9 and 10 ensuring the prism is achieved by this method in the correct orientation with respect to cylinder, bifocal segments, etc.

Insert 25 may then be placed around periphery 7 of front mould 1 (or equally well on periphery 8 of back mould 2). The hole 33 is adapted and aligned to allow the insertion of injection means 32 into volume 31.

The central distance between the two moulds 1 and 2 is then determined by measuring means (not shown). The measuring means

determining the distance between moulds 1 and 2 by utilising the known separation of the holders 17 and 18, stored data about the dimensions of moulds 1 and 2, and calculating the effect of the applied prism on the central distance between the moulds 1 and 2. Holder 18 is then driven towards mould 1 by driving means (not shown) to obtain the required central separation of moulds 1 and 2. Tape 26 is then wound round the moulds 1 and 2 forming volume 31 as shown in figure 5. "V"-blocks 27 and 28 engage periphery 7 of front mould 1 allowing the removal of holder 17. "V"-blocks 29 and 30 engage periphery 8 of back mould 2 allowing the removal of holder 18.

The whole assembly is then rotated through 90° about an axis orthogonal to the optical axis of front mould 1.

Injection/sensing unit 34 unit then advances injection means 32 through tape 26 and hole 33 to enable the injection of a radiation curable plastic material, which is optically transparent, into volume 31. Unit 34 determines when the required amount of the plastic material has been injected into volume 31 and stops the flow of the plastic material. Unit 34 then withdraws injection means 32 from the hole 33 and tape 26. The plastic material is then irradiated with the curing radiation by source 35 until the plastic material has been gelled, but not fully cured. The assembly containing the moulds, gelled plastic material and tape is then transferred to UV/heat oven (not shown) for full curing. After the removal of tape 26 insert 25 is released from front mould 1 thereby enabling a tool (not shown) to be partially inserted

between moulds 1 and 2 to aid in the separation of the moulds 1 and 2 from the cured plastic material.

Claims:

1. A method of casting plastic lenses from a radiation curable plastic material comprising the steps of separately holding first and second moulds, at least one of which is transparent to the curing radiation, positioning them relative to one another so as to define the front and back surfaces of a lens to be cast, clamping the moulds in position, applying a sleeve to form a closed cavity between the moulds, filling the cavity with the radiation curable plastic material and curing the material by exposure to radiation until the plastic material is capable of keeping the first and second moulds in the desired spaced apart relationship when the mould clamps are removed before final curing.

2. A method of casting plastic lenses according to claim 1 in which the curing radiation is ultra-violet radiation.

3. A method of casting plastic lenses according to claim 1 or 2 in which the plastic material is cured until it reaches the gelled state.

4. A method of casting plastic lenses according to any one of claims 1 to 3 in which the radiation transparent mould allows uniform transmission of the curing radiation through the mould.

5. A method of casting plastic lenses according to one of claims 1 to 4 in which the radiation transparent mould is a glass mould.

6. A method of casting lenses according to any one of claim 1 to 5 in which the sleeve is in the form of an adhesive tape.

7. A method of casting lenses according to any one of claims 1 to 6 in which the radiation curable plastics material will gell in about one to about sixty seconds on exposure to the curing radiation.

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